The Promise of Multi-angle Imaging for Deducing Aerosol Properties, Routinely and Globally

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Earth Observing System's MISR, the Multi-angle Imaging SpectroRadiometer, is a new type of satellite instrument. It will measure upwelling visible radiance from Earth in 36 channels: 4 spectral bands centered at 446, 558, 672, and 866 nm, at each of 9 emission angles spread out in the forward and aft directions along the flight path at 70.5, 60.0, 45.6, 26.1 degrees, and nadir. The data will be used to characterize aerosol amount and type, surface albedo and bi-directional reflectance, and cloud properties. MISR is scheduled for launch into a 10:30 AM, sun-synchronous, polar orbit aboard the EOS Terra spacecraft in 1999; the nominal mission lifetime is 6 years.

Aerosol retrieval sensitivity studies show that with the multi-angle, multi-spectral MISR data, under good observing conditions we should be able to distinguish about 3 size groupings among typical atmospheric particles ("small," "medium," and "large"), two colors ("absorbing" and "non-absorbing"), and two shapes (spherical and nonspherical) (Kahn et al., 1998; 1997). These groupings are enough to distinguish among air masses containing different mixtures of particles. Additional data from field measurements within air masses will still be needed to characterize particle single scattering albedo in enough detail to satisfy the needs of climate modelers. But this ability represents a major step beyond current satellite-derived aerosol products, which retrieve total column optical depth for assumed particle properties.

These conclusions are based on "generic" aerosol retrieval simulations, which solve for the cross-section-mean-weighted properties of particles in the column with a minimum of assumptions. To identify aerosol source regions, track the evolution of air masses, and compare MISR data to in situ samples and aerosol transport model results, the actual mixture of particle types must be deduced. Our "climatological" retrieval asks what ranges of mixes of commonly occurring particle types are allowed by the MISR observations. From existing aerosol transport model results, we abstracted a simplified climatology of about a dozen representative mixtures, each containing specified proportions of 4 particle types, that give a good first-order picture of expected global, monthly aerosol behavior. We then tested the ability of MISR to distinguish among these mixtures over dark water surfaces. The results of this theoretical study suggest that with actual MISR data, we may be able to advance current aerosol climatologies with monthly maps, covering major portions of the planet, showing the movements of naturally occurring aerosol air masses.